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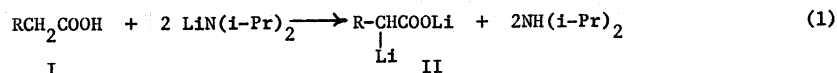
α -ANIONS OF CARBOXYLIC ACIDS. III PREPARATION
OF ALDEHYDES AND NITROPARAFFINS

Philip E. Pfeffer and Leonard S. Silbert

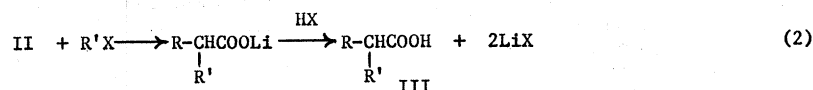
Eastern Utilization Research and Development Division¹
Philadelphia, Pennsylvania 19118

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The quantitative transformation of straight chain carboxylic acids (I) to the α -anion (II) (Equation 1) was recently achieved by the use of hexamethylphosphoramide (HMPA) as a cosolvent in



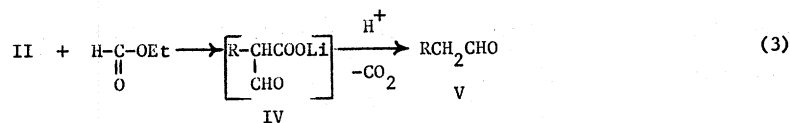
tetrahydrofuran (1,2,3). HMPA advantageously solvates many metalated compounds (4) and thus appears to control α -alkylations in forming the corresponding α -alkylated acids (III) (Equation 2). The



utility of high-yield α -alkylations is presently limited to the straight chain acids as the α -branched acids lend themselves poorly to additional α -alkylation by this reaction (1,2).

Since reactive anions are highly responsive to electrophilic reagents, the preparation of the α -anion of straight chain acids extends their range of versatile reactions for obtaining desired products. Some of these products were formerly obtained from carboxylic acids indirectly and often inconveniently. The synthesis of aldehydes and nitroparaffins reported in this communication are two examples of such reactions. In effect, they may be classified as displacement reactions of the carboxylic acid grouping.

Aldehydes: The addition of ethyl formate to an α -anion (2:1 mole ratio, respectively) at -70°C is accompanied by warming to -40°C . The solution is stirred at this temperature for 30 minutes to complete the reaction. The intermediate α -aldehyde carboxylate salt (IV), (Equation 3) is not



¹Agricultural Research Service, U. S. Department of Agriculture.

isolated but upon neutralization it decarboxylates to the aldehyde (V) containing the same number of carbon atoms per chain as the parent acid. The solution is neutralized at -30° to -40° with dilute HCl (10%) in the presence of Thymol Blue indicator, a saturated solution of NaHSO_3 is added, and the precipitated bisulfite-aldehyde adduct is filtered and collected. The filtrate is saturated with Na_2SO_4 to salt out any bisulfite-aldehyde adduct remaining in solution. The aldehydes are regenerated from the adduct with H_2SO_4 (20%) solution and extracted with pentane (5). Long-chain aldehydes were isolated as trimers which may be readily converted to the monomeric aldehydes by distillation.

The yields of aldehydes prepared from several acids are assembled in Table I. Although the

TABLE I

Yields of Aldehyde: Reactions of α -Anions with Ethyl Formate

Starting acid	Product	% Yield ^a
2-Methyl Pentanoic	2-Methyl Pentanal	35
Heptanoic	Heptanal	65
Nonanoic	Nonanal	60 (78) ^b
Dodecanoic	Dodecanal	40 ^c
Tetradecanoic	Tetradecanal	35 ^d
<u>cis-9-Octadecenoic</u>	<u>cis-9-Octadecenal</u>	30

a/ All yields are based on distilled or recrystallized products. Satisfactory elemental analyses were obtained on all aldehydes as 2,4 dinitro phenylhydrazones.

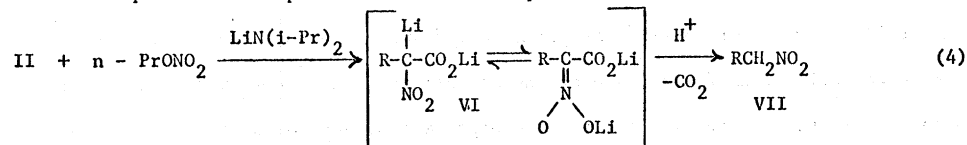
b/ Crude yield by gas chromatographic analysis before further purification.

c/ Obtained as a trimer m.p. 56-56.5, lit 57^o (6).

d/ Obtained as trimer m.p. 65.5, lit 65.5 (7). Both trimers may be quantitatively distilled at reduced pressure to their monomeric aldehydes.

yields range from low to moderate, the example of nonanal illustrates the relatively high conversions that may be attained. The method is not limited to saturated acids since unsaturated aldehydes (cis-9-octadecenal) are also obtained without altering the double bond (2). In this respect, the method is superior to the Rosenmund acid chloride reduction (8) and to the direct reductive trans-formation of acids to aldehyde via lithium in ethylamine (9), which reduce or further modify the double bond. α -Branched acids (2-methyl pentanoic acid) give lower yields as expected for the effect of hindrance by α -branching, although the yields are lower than anticipated for the small size of this alkyl branch (2).

Nitroparaffins: These compounds are prepared in an analogous manner by addition of n-propyl nitrate to the α -anion (3:1 mole ratio, respectively) at -40°C . Acidification of the mixture afforded decarboxylation of the intermediate α -nitro carboxylate salt (VI) to yield the nitroparaffin (VII) as formulated in Equation 4. Separation of the nitroparaffin from unreacted carboxylic acid



is simply effected by eluting the mixture with pentane-benzene through a small column of fluorosil. Examination of the reaction mixture by glc before fluorosil treatment showed the absence of nitrites. The yields of nitroparaffins prepared in this study are assembled in Table II. α -Branched acids did not form the corresponding nitro derivative.

TABLE II

Yields of Nitroparaffins: Reaction of α -Anions with n-Propylnitrate^a

<u>Starting acid</u>	<u>Product</u>	<u>% Yield</u> ^b
Nonanoic	1-Nitrooctane	68 (50) ^c
Dodecanoic	1-Nitroundecane	53 (66) ^d
Tetradecanoic	1-Nitrotridecane	50
<u>cis-9-Octadecenoic</u>	1-Nitro- <u>cis-8</u> -Heptadecene	45

^{a/} 3 moles of lithium diisopropylamide used except where indicated.

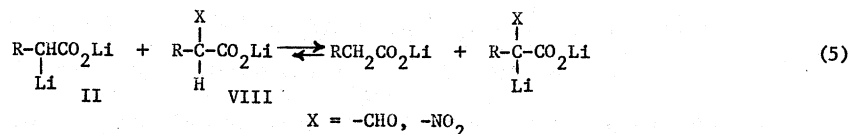
^{b/} All yields are based on purified products. Satisfactory elemental analyses were obtained on all products.

^{c/} 2 moles of lithium diisopropylamide used.

^{d/} % conversion determined by gas chromatographic analysis.

This single stage, α -anion procedure offers an improved alternative to the indirect methods of reacting α -haloacids (10) or α -haloesters (11) with sodium nitrite or alkyl nitrates. Alpha nitration of nitriles is another preparative approach to nitro compounds; however, this procedure is limited only to the preparation of nitromethane and phenylnitromethane (12).

Remarks: The yields of aldehydes and nitroparaffins obtained by the α -anion technique are fair compared to the corresponding quantitative yields of α -alkyl acids. The yields of aldehydes and nitroparaffins are suppressed by a competitive lithium-hydrogen exchange in operation in both reactions as formulated in Equation 5.



An acidic α -proton present in the aldehyde and nitro intermediates (VIII) exchanges with the α -anion in an equilibrium (I) which depletes the concentration of this reagent. Acidification regenerates the starting acid as the only accompanying product made available by the nature of their equilibria. The admission of an additional mole of base (lithium diisopropylamide) to the nitration reaction improves the yields of nitroparaffins (see Table II) but higher base ratios cause no further improvement. Inverse addition of the α -anion (I) to n-propyl nitrate also has no effect on yields. In the aldehyde preparations, neither inverse addition nor excess base improves the yields.

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